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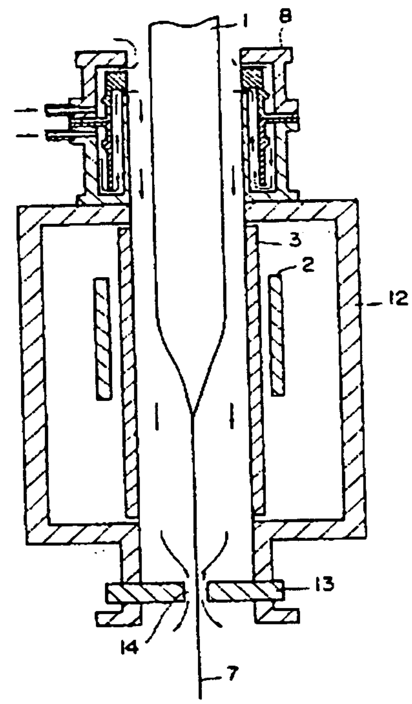
TITLE : FURNACE FOR DRAWING OPTICAL FIBER



ABSTRACT : PURPOSE: To keep an atmospheric gas flow in a furnace constant and obtain an optical fiber with hardly any fluctuation in wire diameter, by combining a discharge outlet of an inert gas in a gas diffuser and a flow passage communicating with the discharge outlet and preheating part so as to provide specific action.

CONSTITUTION: A high-pressure part is formed by retention of flow in a space sandwiched between an upper sealing gas and lower sealing gas. Thereby, the upper sealing gas mainly discharges upward to seal the opening at the upper end of a diffuser 8 from the outside air. The lower sealing gas mainly discharges downward to seal an opening 14 of a shutter provided at the opening of the lower end of the furnace body from the outside air. At this time, since the lower sealing gas is heated by radiant heat from the atmosphere in the furnace or furnace core tube 3 and heat transfer from the furnace body 12, the gas flows down while minimizing the occurrence of turbulent flow without cooling an optical fiber preform 1. Furthermore, the flow rate and flow velocity of the upper sealing gas and lower sealing gas can be respectively regulated to control the respective flows and enhance sealing effects. As a result, stabilization of the atmosphere in the furnace can be simultaneously contrived.

TRANSLATION FROM JAPANESE

D1

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(54) Optical-fiber drawing furnace

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SPECIFICATION

1. Title of the invention

Optical-fiber drawing furnace

2. Claim

Optical-fiber drawing furnace, characterized by consisting of a furnace core tube through which optical fiber base material is inserted vertically downward, a heater wound on the above furnace core tube, a furnace body surrounding the above furnace core tube and the heater, and a gas diffuser for an inert gas seal installed integrally at the upper open part of the above furnace body, wherein an inert-gas upper discharge opening and an inert-gas lower discharge opening positioned below the upper opening are installed on the inner wall of the

above gas diffuser, with flow paths independently connecting to the above upper discharge opening and lower discharge opening being installed inside the above gas diffuser and with one of the above flow paths reaching to the area above the lower discharge opening having a preheating part along the inner wall of the diffuser.

3. Detailed explanation of the invention

Industrial field of the application

The present invention concerns an optical-fiber drawing furnace capable of drawing optical fibers with a small diameter fluctuation by keeping the atmosphere gas flow constant inside the furnace.

Prior art

In the case of drawing optical fibers by softening of the tip of an optical fiber base material in a rod shape in a furnace by heating and drawing, to prevent degradation of the parts inside the furnace and for stable manufacture of optical fibers of high quality, an inert gas is introduced from the upper part of the furnace for sealing the optical fiber base material and the drawn optical fiber part from the outside atmosphere in the furnace. In this method, it is most important that the inert-gas flow inside the furnace be a stable laminar flow. However, this is difficult to obtain, and various methods have been tried. For example, in Japanese Kokoku Patent Nos. Sho 52[1977]-117644 and Sho 53[1978]-72634, the structure of the diffuser, namely an opening for blowing inert gas onto the optical fiber base material, is improved to obtain a laminar flow distribution state. Also, before introduction into the furnace, the inert gas is heated to a temperature close to the furnace interior temperature for stable flow inside the furnace as shown in Japanese Kokoku Patent No. Sho 52[1977]-119949. Such prior-art technology is shown in Figures 4 and 5.

This optical-fiber drawing furnace consists of comprising a furnace core tube (3) through which optical fiber base material (1) is inserted vertically downward, a heater (2) wound on the above furnace core tube, a diffuser (8) integrally installed at the upper edge of the furnace core tube (3); a flow rate control (4), flowmeter (5) and inert gas heater (6) connected in the that order in the flow direction in the middle of flow path for feeding the inert gas are fitted to the diffuser (8) with its bottom (10) making contact the upper end of the furnace core tube (3). As shown in Figure 5, the diffuser (8) has a hollow ring structure; its outer wall is connected to the inert gas feeding pipe (11) at one point, discharging the inert gas from the entire inner wall through the continuous foam (9).

In using this drawing furnace, by the heater (2), the atmosphere inside the furnace tube (3) is heated to the desired temperature, then the inert gas for a seal is heated by the heater (6) to a temperature close to that of the furnace core tube (3) interior, while the feeding flow rate is optimized by the flowmeter (5) and flow rate control (4). The optical fiber base material (1) is then lowered through the furnace core tube (3) and drawn to obtain the optical fiber (7).

Problems to be solved by the invention

In the example of the prior art for the optical-fiber drawing furnace shown in Figure 4, when the optical fiber base material (1) is heated and drawn, an inert gas is introduced from the upper part of the furnace and the optical fiber base material (1) and the drawn optical fiber (7) are sealed from the outside atmosphere. However, the furnace interior temperature needed for drawing heat-softened optical fiber base material (1) exceeds 2000°C, and a strong convection current is formed in the furnace inside atmosphere from the lower opening to the upper opening of the furnace. This collides with the inert gas introduced from the furnace top, at the middle of the furnace interior, producing turbulence. This turbulent flow imparts stress directly onto the optical fiber (7) drawn to a fine diameter; at the same time, heat is removed from the front end of the heat-softened optical fiber base material (1), creating a localized temperature gradient, leading to internal stress formation. As a result, the fluctuation in the diameter of the drawn optical fiber (7) is increased. Thus, to maintain the gas flow inside the furnace in the laminar flow state, as shown in the prior art shown in Figures 4 and 5, efforts have been made to improve the shape of the diffuser (8) for the inert gas and to heat the introduced inert gas by the heater (6) to a temperature close to the furnace interior temperature. The conventional diffuser (8) shown in Figure 5 has a hollow ring structure, with inert-gas feed tube (11) being connected to one site on the outer wall in such a way that the inert gas is discharged from the entire inner wall through a continuous foam (10). When the inert gas is discharged from the discharge opening of the diffuser (8), it blows almost perpendicular to the outer surface of the optical fiber base material (1); the upper layer of the flow is led to the upper part of the diffuser (8) and the lower layer of the flow is led to the lower part of the diffuser (8) and fed into the furnace core tube (3), resulting in sealing of the upper and lower ends of the furnace from the outside atmosphere. In this case, since the inert gas fed into the furnace is already heated by the heater (6) shown in Figure 4 to a temperature close to the furnace interior temperature, the localized convection flow caused by the temperature difference from the heated atmosphere inside the furnace can be prevented, and the turbulent flow formed at the interface of the inert gas flowing in and the heated atmosphere can be totally stabilized. However, the problems caused by the temperature difference between the inert gas flowing in and the heated atmosphere inside the furnace concerns only the inert-gas flow divided downward after blowing of the inert gas discharged

from the inner wall of the diffuser (8) of Figure 4 onto the optical fiber base material (1). Namely, the inert-gas flow divided upward is readily discharged from the upper opening of the furnace, so this flow has the action of sealing mainly the upper opening part of the furnace, with entirely no direct influence on stabilization of the atmosphere inside the furnace. Therefore, preheating the inert gas that is discharged from the diffuser (8) and divided upward on the outer surface of the optical fiber base material (1) is not necessary, and doing so will only bring about an increased operating cost. Also, in the conventional drawing furnace shown in Figure 4, a heater (6) for dedicated preheating of the inert gas is installed. This is not efficient in terms of excess heat utilization of the heater (2) inside the furnace, namely, the overall energy efficiency of the entire apparatus. To enhance the seal effect by the inert gas and to maintain the laminar flow state of the inert gas inside the furnace, it may be necessary to optimize the flow rate of each of the flow upward and flow downward along the optical fiber base material (1). However, in the diffuser (8) for the conventional drawing furnace shown in Figure 5, the inert gas is discharged from a single discharge opening and blown to the outer surface of the optical fiber base material (1), then divided into upper and lower flows, so there is the problem of difficulty in controlling each flow independently.

Means for solving the problems

The optical-fiber drawing furnace of the present invention is characterized by consisting of a furnace core tube through which optical fiber base material is inserted vertically downward, a heater wound on the above furnace core tube, a furnace body surrounding the above furnace core tube and the heater, and a gas diffuser for an inert gas seal installed integrally at the upper open part of the above furnace body, wherein an inert-gas upper discharge opening and an inert-gas lower discharge opening positioned below the upper opening are installed on the inner wall of the above gas diffuser, flow paths independently connected to the above upper discharge opening and lower discharge opening are installed inside the above gas diffuser, with one of the above flow paths reaching to the above lower discharge opening having a preheating part along the inner wall of the diffuser.

Function

The inert gas from the two types of discharge openings installed on the inner wall of the diffuser is discharged to the outer surface of the optical fiber base material inserted into the preheated furnace inside atmosphere. Namely, from the upper discharge opening installed on the upper part of the inner wall of the diffuser, the inert gas led through the flow path of the diffuser interior is discharged and flows out mainly to the upper part along the optical fiber base material, creating a sealing

effect at the upper end opening of the diffuser. From the lower discharge opening positioned below the upper discharge opening, the inert gas led through the preheating part formed along the diffuser inner wall of the diffuser inner flow path is discharged and mainly flows down along the optical fiber base material, creating a sealing effect at the lower end opening of the furnace body. While the inert gas discharged from the lower discharge opening passes through the preheating part formed along the diffuser inner wall of the diffuser inner flow path, the atmosphere inside the furnace is heated by the heat from the furnace body, thus the temperature difference from the heated atmosphere inside the furnace is reduced without needing an independent heater. As a result, the turbulent flow formed by collision of the inert gas, flowing down the furnace interior after being discharged from the lower discharge opening, with the atmosphere inside the furnace is effectively suppressed. Since the upper discharge opening and lower discharge opening are connected to independent inlets, the inert gas flowing through the inlets can be controlled to obtain optimum flow states.

Practical example

An example of the present invention is illustrated by the schematic cross-sectional diagram of Figure 1, consisting of a furnace core tube (3) through which optical fiber base material (1) is inserted vertically downward, a heater (2) wound on the above furnace core tube, a furnace body (12) surrounding the above furnace core tube (3) and the heater (2), a shutter (13) attached to the lower opening of the furnace body (12) and that has an optical fiber (7) discharge outlet (14), and a gas diffuser (8) for an inert gas seal installed integrally at the upper open part of the above furnace body (12).

The above diffuser (8) has the following constitution. Namely, as shown in Figure 2, a circular lower end barrier wall (17) is integrally placed at the upper end of the furnace body (12), and on the upper end of the lower barrier wall (17), a cylindrical lower outer barrier wall (18) is formed as an integral structural part vertical to the lower barrier wall (17). At the upper end of the lower barrier wall (17) inside the lower outer barrier wall (18), as an integral structural part with the lower barrier wall (17), the lower inner barrier wall (19) vertical to the lower barrier wall (17) is formed concentrically with respect to the lower outer barrier wall (18). In the space surrounded by the lower outer barrier wall (18), lower barrier wall (17), and lower inner barrier wall (19) a cylindrical lower inner barrier wall (21) having a diameter larger than the outer diameter of the lower inner barrier wall (19) and smaller than the inner diameter of the lower outer barrier wall (18) is installed concentrically with respect to the lower outer barrier wall (18) and the lower inner barrier wall (19); the flange (22) installed on the upper end of the the lower inner barrier wall (21) is fixed in an airtight manner on the

flange (20) installed on the upper end of the lower outer barrier wall (18). The space (33) surrounded by the lower outer barrier wall (18) and the outer surface of the lower inner barrier wall (21) and the space (34) surrounded by the inner surface of the lower inner barrier wall (21) and outer wall of the lower inner barrier wall (19) each form the inert-gas flow paths (33, 34) with a uniform width in the inner wall direction. Here, at the outer surface upper part of the lower inner barrier wall (21), a circular protrusion part, namely, lower inert-gas narrowing part (31) is installed, thus the inert-gas flow path (33) formed by the inner surface of the lower outer barrier wall (18) and the outer surface of the lower inner barrier wall (21) is narrowed over the entire circular periphery near its inlet, and the gas flow led to the lower inlet tube (16) is narrowed by the above inert-gas narrowing part (31) and transformed into a uniform flow along the entire circular periphery.

At the upper part of the above lower inner barrier wall (21), the upper inner barrier wall (23) having about the same inner diameter as the lower inner barrier wall (21) is concentrically and integrally installed; the flange (24) installed at the lower end of the upper inner barrier wall (23) is fixed to the flange (22) installed at the upper end of the lower inner barrier wall (21). The integral wall surface, with the same inner diameter formed by the inner surface of the upper inner barrier wall (23) and the inner surface of the lower inner barrier wall (21), and the space (34) surrounded by the outer surface of the lower inner barrier wall (19) at about the same length form preheated flow path (34) of the inert gas having a uniform width in the inner periphery direction. With this flow path (34), the inert-gas flow is heated by the heat from the furnace interior via the inner surface of the lower inner barrier wall (19) directly in contact with the atmosphere inside the furnace, then a uniform high-temperature seal gas is discharged onto the entire periphery of the optical fiber base material (1) from the lower discharge opening (29) formed by the inner flange (25) installed as an integral structural part with the upper inner barrier wall (23) at the upper end of the upper inner barrier wall (23) and the upper end of the lower inner barrier wall (19). Outside the above upper inner barrier wall (23), the cylindrical upper outer barrier wall (26) having a diameter larger than the outer diameter of the upper inner barrier wall (23) is wound concentrically with respect to the upper inner barrier wall (23); the flange (27) installed at the lower end of the upper outer barrier wall (26) is fixed in an airtight manner to the flange (24) installed at lower end of the upper inner barrier wall (23). The space (35) between the outer surface of the upper inner barrier wall (23) and the inner surface of the upper outer barrier wall (26) forms the inert-gas flow path (35) having a uniform width in the inner periphery direction. At the outer surface lower part of the upper inner barrier wall (23), a circular protrusion part, namely, upper inert-gas narrowing part (32) is installed. By this upper inert-gas narrowing part (32), the inert-gas flow path (35) formed by the inner surface of the upper inner barrier wall (23) and the inner surface of the upper outer barrier wall (26) is narrowed over the entire periphery near its inlet; the gas flow led from the upper inlet tube (15) is narrowed by the

above upper inert-gas narrowing part (32) and is transformed into a uniform flow along the entire periphery. This flow rises through the flow path (35) formed by the above upper outer barrier wall (26) and the upper inner barrier wall (23), passes through the flow path (36) formed by the upper end barrier wall (28) installed at the upper end of the upper outer barrier wall (26); which is an integral structural part with the upper outer barrier wall (26) and inner flange (25) installed as an integral structural part with the upper inner barrier wall (23) at the upper end of the upper inner barrier wall (23), then is discharged from the upper discharge opening (30).

The upper seal gas that is discharged from the upper discharge opening (30) and blown evenly onto the outer surface of the optical fiber base material (1) is divided into upper and lower flows on the outer surface at the same time, the lower seal gas discharged from the lower discharge opening (29) is similarly divided. Thus, the flow dwells in the space between the upper seal gas and lower seal gas, creating a high pressure part. As a result, the upper seal gas flows out mainly upward, sealing the upper opening part (37) of the diffuser (8), and the lower seal gas flows out mainly downward, sealing the opening part (14) of the shutter installed at the lower end opening part of the furnace body from the outside atmosphere. At this time, the lower seal gas is heated by the preheated atmosphere inside the furnace or by radiative heat from the furnace core tube (3) and the convection heat from the furnace body (12), minimizing the formation of turbulent flow and flowing down the furnace interior without cooling the optical fiber base material (1). These upper and lower seal gases can be controlled individually with respect to the flow rate for improved sealing effects with stabilization of the atmosphere inside the furnace, thus the drawn optical-fiber (7) diameter fluctuation can be reduced.

While one seal-gas inlet tube is installed for each lower and upper seal gas in the above example, additional inlet tubes can be installed to obtain a flow uniform in the direction of the periphery, and the narrowing effects can be controlled by changing the shape and position of each narrowing part (31, 32) of the seal-gas flow paths (33, 35). Also, the preheating flow path (34) for preheating the lower seal gas can be increased in the heat conduction area by changing the cylindrical path flow path of the above example into a wavy form. The outer surface of the lower inner barrier wall (19) may be fitted with spiral fins, making the preheating flow path into a spiral form, or a number of plate fins can be installed in the upright direction on the outer surface of the lower inner barrier wall. The heating effects may be increased by placing the preheating flow path (34) close to the heater (2) inside the furnace body (12). Also, for example, in the structural part, the upper inner barrier wall (23) and the lower inner barrier wall (21) may be made into an integral structural part. A complicated structure is of no concern as long as an inert-gas upper discharge opening (30) is installed at the upper part of the inner wall of the diffuser (8), the inert-gas lower discharge opening (29) is installed at the lower position, an individual flow path is connected to each

discharge opening inside the diffuser (8), and the flow path reaching the lower discharge opening (29) has a preheating part along the inner wall of the diffuser (8).

Effects of the invention

According to the optical-fiber drawing furnace of the present invention, flow paths and inlet tubes are independently connected to two types of seal-gas discharge openings for sealing the optical fiber base material to be drawn and to separate the optical fiber itself from the outside atmosphere in the furnace, so that each seal gas discharged independently from the two types of openings seals the upper opening part and lower opening part of the drawing furnace from the outside atmosphere. It is possible to control the flow rates of the two types of seal gases independently, to attain near perfect sealing effects at the upper opening part and lower opening part of the drawing furnace. At the same time, the seal gas flowing down the furnace core tube interior can be independently controlled with respect to the flow amount and flow speed, to easily promote a stable laminar flow. Also, the seal gas flowing down inside the drawing furnace is preheated by the preheating part formed along the inner wall surface of the diffuser to make forming a turbulent flow with the hot atmosphere inside the furnace difficult, and the optical fiber diameter fluctuation can be suppressed without cooling the optical-fiber base material. It is not necessary to install an independent heater to heat the seal gas, the excess heat from the furnace body is utilized, and it is not necessary to heat even the upper seal gas as in the conventional process, thus the overall energy efficiency is enhanced, resulting in a reduced operation cost.

4. Brief description of the drawings

Figure 1 is a cross-sectional diagram illustrating an approximate structure of an example of the optical-fiber drawing furnace of the present invention. Figure 2 is a detailed cross-sectional diagram of the diffuser part of the optical-fiber drawing furnace shown in Figure 1. Figure 3 is a cross-sectional diagram along the line A-A of the diffuser part of the optical-fiber drawing furnace shown in Figure 2. Figure 4 is a cross-sectional diagram illustrating an approximate structure of a conventional optical-fiber drawing furnace. Figure 5 is a detailed cross section diagram of the diffuser part of the optical-fiber drawing furnace shown in Figure 4.

1 ... optical fiber base material
2 ... heater
3 ... furnace core tube
8 ... diffuser

12 ... furnace body
19 ... lower inner barrier wall
25 ... inner flange
29 ... lower discharge opening
30 ... upper discharge opening
33, 34 ... inert-gas flow path to the lower discharge opening
35, 36 ... inert-gas flow path to the upper discharge opening

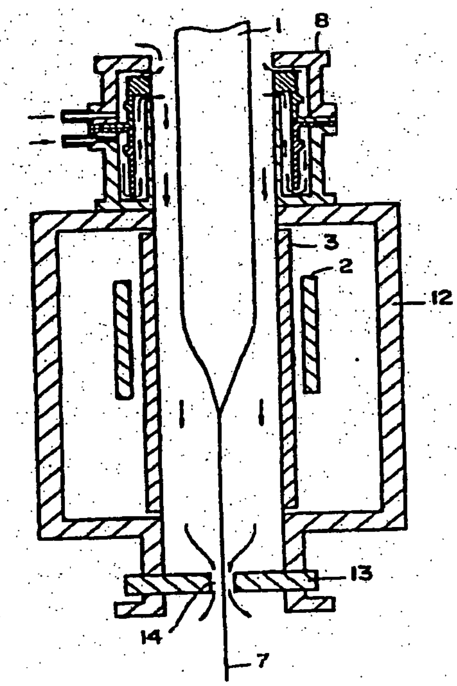

Figure 1

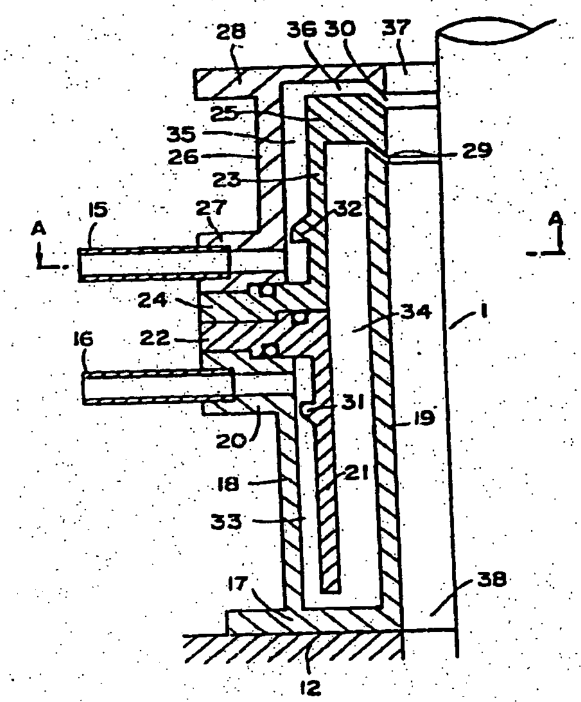

Figure 2

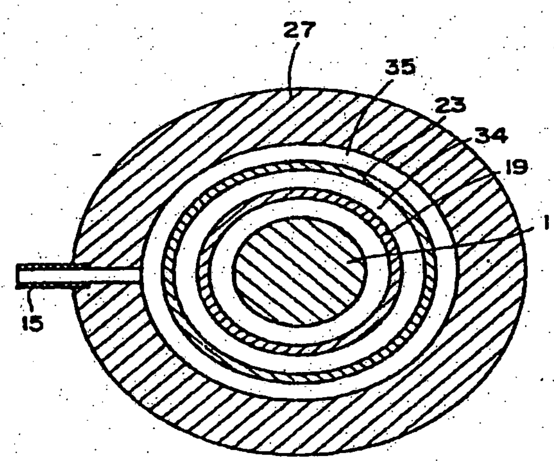

Figure 3

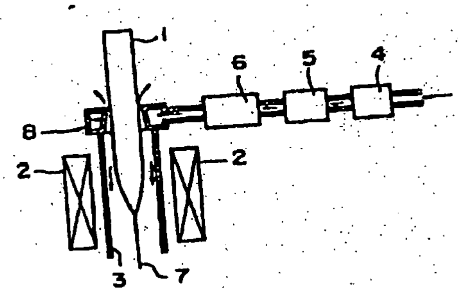

Figure 4

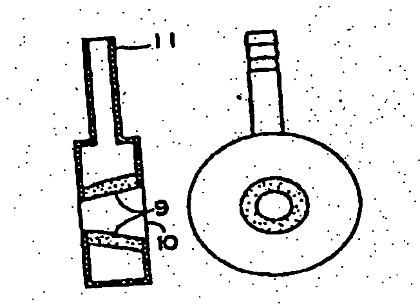

Figure 5

⑲日本国特許庁（JP）　⑪特許出願公開
⑫公開特許公報（A）　平1－192741

⑤Int. Cl.⁴　識別記号　庁内整理番号　㊸公開　平成1年(1989)8月2日
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㊿発明の名称　光ファイバ線引き炉

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㉒出　願　昭63(1988)1月29日

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明　細　書

1. 発明の名称

光ファイバ線引き炉

2. 特許請求の範囲

光ファイバ母材が鉛直下方に挿入される炉心管と、上記炉心管を取り巻くヒータと、上記炉心管及び上記ヒータを囲繞する炉体と、上記炉体の上端開口部に一体的に設けられた不活性ガスシール用のガスディフューザを有する光ファイバ線引き炉において、上記ガスディフューザの内周壁面には不活性ガスの上部放出口と、この上部放出口の下方に位置する不活性ガスの下部放出口とが設けられると共に、上記ディフューザ内部には上記上部放出口及び上記下部放出口の各々に独立して連絡する流路が設けられ、且つ上記下部放出口に至る一方の上記流路には上記ディフューザの内周壁面に沿った予熱部を有するものであることを特徴とする光ファイバ線引き炉。

3. 発明の詳細な説明

<産業上の利用分野>

本発明は、炉内の雰囲気ガスの流れを一定に保って線径変動の少ない光ファイバを線引きする光ファイバ線引き炉に関する。

<従来の技術>

棒状の光ファイバ母材の先端を線引き炉内にて加熱軟化させて延伸し光ファイバに線引きする場合、炉内部品の劣化防止や、高品質の光ファイバを安定して製造するために、炉体上部より不活性ガスを導入し光ファイバ母材及び線引きされた光ファイバ部分を炉体内にて外気よりシールする方法が用いられている。この方法においては炉内の不活性ガスの流れを安定した層流状態に置くことが、最も重要であり且つ困難な課題であるために様々な方法が試みられている。例えば、不活性ガスを光ファイバ母材に吹きつけるための吹出口即ちディフューザの構造等を改良して、層流分布状態の流れを得ようとしたものとして、

特公昭52－11764号や特公昭53－72634号などがある。また、不活性ガスを炉内へ導入する前に予め炉内温度に近い温度まで加熱しておくことにより、炉内での流れの安定化を目ざしたものとして特公昭52－119949号がある。以上のような従来技術としての例を第4図及び第5図に示す。

この光ファイバ線引き炉は、光ファイバ母材1を鉛直下方に挿入する炉心管3と、これを取り巻くヒータ2と、炉心管3の上端にこれと一体的に設けられたディフューザ8と、下端面10が炉心管3の上端に接するディフューザ8へ、不活性ガスを供給するため管路途中に流れ方向から順に連結された以下の機器、流量調整装置4と流量計5と不活性ガス加熱用の加熱器6とを備えている。上記ディフューザ8は第5図に示すように中空のリング構造をなし、その外周壁の1カ所に不活性ガスの供給管11が接続され、内周壁全面より連続気泡体9を通して不活性ガスが放出されるようになっている。

この線引き炉の使用に際しては、予めヒータ2で炉心管3内雰囲気を目的とする温度まで加熱した後、シール用不活性ガスを加熱器6で炉心管3内温度近くまで加熱すると同時に、供給する流量を流量計5と流量調整装置4とを用いて最適となるように調整する。この後光ファイバ母材1を炉心管3内に降下導入して線引きし光ファイバ7を得る。

＜発明が解決しようとする課題＞

第4図に示すような光ファイバ線引き炉の従来技術例においては、光ファイバ母材1を加熱して線引きする際に炉上部より不活性ガスを導入し光ファイバ母材1及び線引き直後の光ファイバ7を炉内にて外気よりシールする。しかし、光ファイバ母材1を加熱軟化させ線引きするに要する炉内温度は2000℃を越えるものであるため、炉内雰囲気には炉の下端開口部より上端開口部へと向かう強い対流が生じ、これが炉上部より導入された不活性ガスと炉内半ばで衝突して乱流が発生する。乱流は、線引きされ微小径化した光ファイバ7に直接的な応力として作用すると同時に、加熱軟化した光ファイバ母材1先端表面から熱を奪い局所的な温度勾配を生んで内部応力を発生させ、その結果線引きされた光ファイバ7の線径変動を増大させてしまう。このため、炉内ガス流を層流状態に保つことを目的として第4図、第5図に示す従来技術例のように不活性ガスのディフューザ8の形状を改良したり、さらには導入する不活性ガスを予め加熱器6を用いて炉内温度近くにまで加熱するなどの試みがなされてきた。第5図に示す従来型のディフューザ8は中空のリング構造をなし、その外周壁の1カ所に不活性ガスの供給管11が接続され、内周壁全面より連続気泡体10を通して不活性ガスが放出されるようになっている。不活性ガスはこのディフューザ8の放出口より放出されると光ファイバ母材1の外周面にほぼ垂直に吹き付けられて、流れの上層はディフューザ8上方へ、流れの下層はディフューザ8下方炉心管3内へと導かれ、それぞれ炉の上端，下端の開口部を外気からシールする。ところでこの時炉内に供給される不活性ガスは第4図に示す加熱器6によって既に炉内温度近くまで加熱されたものであるので、炉内の加熱雰囲気との温度差から生ずる局所的な対流を抑えることができ、流入する不活性ガスと加熱雰囲気との界面に生じる乱流の全体をより安定化することが可能である。しかし、上記のように炉内に流入する不活性ガスと炉内の加熱雰囲気の温度差が問題となるのは、第4図のディフューザ8の内周壁より放出され光ファイバ母材1に吹きつけられ下方に分流した不活性ガスの流れに関してのみである。即ち上方に分流した不活性ガスの流れはすぐに炉の上端開口部より放出されるために、この流れは主に炉の上端開口部のシール作用を持つのであって炉内雰囲気の安定化への直接的な影響力を

殆ど有しない。従ってこのディフューザ8より放出され光ファイバ母材1外周面上で上方へ分流した不活性ガスを予め加熱しておくことはその必要性がないばかりか運転コストを増大させる結果を招く。また同時に第4図に示す従来型の線引き炉では、不活性ガスを予め加熱するために専用の加熱器6が設けられているが、炉内のヒータ2の余熱利用、即ち装置全体のエネルギー効率という点からみれば頗る非効率な構成である。さらには、不活性ガスによるシール効果を高め且つこの不活性ガスの炉内での層流状態を保つために、光ファイバ母材1に沿う炉体上方への流れと炉体下方への流れとを各々最適な流量流速に調整する必要性があるが、第5図に示す従来型の線引き炉用ディフューザ8では、単一の放出口より放出され光ファイバ母材1の外周面吹きつけることで上方と下方に流れを分流させる方式であるために、各々に独立した適切な流れの制御ができないという問題点があった。

＜課題を解決するための手段＞

本発明による光ファイバ線引き炉は、光ファイバ母材が鉛直下方に挿入される炉心管と、上記炉心管を取り巻くヒータと、上記炉心管及び上記ヒータを囲繞する炉体と、上記炉体の上端開口部に一体的に設けられた不活性ガスシール用のガスディフューザを有する光ファイバ線引き炉において、上記ガスディフューザの内周壁面には不活性ガスの上部放出口と、この上部放出口の下方に位置する不活性ガスの下部放出口とが設けられると共に、上記ディフューザ内部には上記上部放出口及び上記下部放出口の各々に独立して通絡する流路が設けられ、且つ上記下部放出口に至る一方の上記流路には上記ディフューザの内周壁面に沿った予熱部を有するものであることを特徴とするものである。

＜作　　用＞

予め加熱された炉内雰囲気中に挿入された光ファイバ母材の外周面には、ディフューザの内周壁面に設けられた2系統の放出口より不活性ガスが放出される。即ちディフューザの内周壁面上部に設けられた上部放出口からは、ディフューザ内部の流路を経て導かれた不活性ガスが放出され、光ファイバ母材に沿って主に上方へ流出してディフューザ上端開口部でのシール効果を生み、上記上部放出口の下方に設けられた下部放出口からは、ディフューザ内部流路のディフューザ内周壁面に沿って形成された予熱部を経て導かれた不活性ガスが放出され、光ファイバ母材に沿って主に下方へ流下し炉体下端開口部でのシール効果を生む。さらには上記下部放出口より放出される不活性ガスは、ディフューザ内部流路のディフューザ内周壁面に沿って形成された予熱部を通過するうちに炉内雰囲気或は炉体からの伝熱によって加熱されるので、独立した加熱器を要することなく炉内の加熱雰囲気との温度差が減少する。この結果、下部放出口より放出され炉内を流下してゆく不活性ガスと炉内雰囲気とが衝突して生じる乱流の形成がより効率的に抑止される。また上記上部放出口及び上記下部放出口は独立した流路で各々の導入口と通絡しているために、各々の導入口に流し込む不活性ガスの流量流速を制御して最適な流れの状態を実現しうる。

＜実　施　例＞

本発明による一実施例は、第1図の概略断面図によって示されるように、線引きされる光ファイバ母材1が鉛直下方に挿入される炉心管3と、これを取り巻くヒータ2と、上記炉心管3と上記ヒータ2を囲繞する炉体12と、上記炉体12の下部開口部に取り付けられた光ファイバ7の取り出し口14を有するシャッタ13と、上記炉体12の上端開口部に一体的に設けられた不活性ガスシール用のディフューザ8とを備えている。

上記ディフューザ8の構成は以下のようになっている。即ち第2図に示されるように炉

体１２の上端面には円盤状の下端隔壁１７が一体的に載置されており、下端隔壁１７の上端面にはこれと垂直に円筒状の下部外周隔壁１８が下端隔壁１７と一体の構造部材として形成され且つ下部外周隔壁１８内側の下端隔壁１７の上端面にはやはり下端隔壁１７と一体の構造部材として下端隔壁１７と垂直に下部内周隔壁１９が下部外周隔壁１８と同心状に形成されている。さらに下部外周隔壁１８と下端隔壁１７と下部内周隔壁１９の挟む円筒状の空間には、下部内周隔壁１９の外径より大きく下部外周隔壁１８の内径より小さい径を有する円筒状の下部内隔壁２１が下部外周隔壁１８及び下部内周隔壁１９と同心状に設けられており、下部外周隔壁１８の上端に設けられたフランジ２０に下部内隔壁２１の上端に設けられたフランジ２２が気密に重ねられ固定されている。こうして下部外周隔壁１８の内周面と下部内隔壁２１の外周面とが挟む空間３３及び下部内隔壁２１の内周面と下部内周隔壁１９の外周面とが挟む空間３４とは内周方向に各々一様な幅を有する不活性ガスの流路３３，３４を形成する。ここで、下部内隔壁２１の外周面上部には円環状の突起部即ち下部不活性ガス絞り部３１が設けられていて下部外周隔壁１８の内周面と下部内隔壁２１の外周面とが形成する不活性ガスの流路３３をその入口付近で全円周にわたって狭めており、下部導入管１６にて導かれたガス流は上記不活性ガス絞り部３１によって絞られ全円周に沿って一様な流れに変えられる。

上記下部内隔壁２１の上部にはさらに下部内隔壁２１と内径が等しく且つ同心である上部内隔壁２３が一体的に載置されており下部内隔壁２１の上端に設けられたフランジ２２には上部内隔壁２３の下端に設けられたフランジ２４が重ねられ固定されている。上部内隔壁２３の内周面と下部内隔壁２１の内周面とが形成する同一内径の一体的な壁面と、これにほぼ等しい長さを持つ下部内周隔壁１９の外周面とが挟む空間３４は、内周方向に一様な幅を有する不活性ガスの予熱流路３４として形成され、この流路３４で不活性ガスの流れは炉内雰囲気と直接接する下部内周隔壁１９の内周面を介して炉内からの伝熱により加熱された後、上部内隔壁２３の上端に上部内隔壁２３と一体の構造部材として設けられた内フランジ２５と下部内周隔壁１９の上端部とが形成する下部放出口２９より光ファイバ母材１の全周にわたって均一且つ高温のシールガスとして放出される。さらに上記上部内隔壁２３の外側には上部内隔壁２３の外径より大きな径を有する円筒状の上部外周隔壁２６が上部内隔壁２３を同心状に取り巻いており、上部内隔壁２３の下端に設けられたフランジ２４には上部外周隔壁２６の下端に設けられたフランジ２７が気密に重ねられ固定されている。上部内隔壁２３の外周面と上部外隔壁２６の内周面とが挟む空間３５は内周方向に一様な幅を有する不活性ガスの流路35として形成され、同時に上部内隔壁２３の外周面下部には円環状の突起部即ち上部不活性ガス絞り部３２が設けられている。この上部不活性ガス絞り部３２は、上部内隔壁２３の外周面と上部外周隔壁２６の内周面とが形成する不活性ガスの流路３５をその入口付近で全円周にわたって狭めており、上部導入管15より導かれたガス流は上記上部不活性ガス絞り部３２によって絞られ全円周に沿って一様な流れに変えられる。さらにこの流れは、上記上部外周隔壁２６と上部内隔壁２３との形成する流路３５を上昇したあと、上部外周隔壁２６と一体の構造部材として上部外周隔壁２６上端部に設けられた上端隔壁２８と、上部内隔壁２３の上端部に上部内隔壁２３に一体的な構造部材として設けられた内フランジ２５とが形成する流路３６を経てこれに連通する上部放出口３０より放出される。

上部放出口３０より放出され光ファイバ母材１の外周面に一様に吹きつけられた上部シ

ールガスは外周面上で上方及び下方へ分流しうるが、同時に下部放出口29より放出された下部シールガスも外周面上で同様に上方及び下方へと分流しうる。従って上部シールガスと下部シールガスの挟む空間で流れが滞留して高圧部が生じ、このため上部シールガスは主に上方へ流出してディフューザ8の上端開口部37を外気からシールし、下部シールガスは主に下方へ流出して炉体下端開口部に設けられたシャッタの開口部14を外気よりシールする。この時下部シールガスは予め炉内雰囲気或は炉心管3からの輻射熱及び炉体12よりの伝熱によって加熱されたものであるから、乱流の発生を最小限にとどめながら且つ光ファイバ母材1を冷やすことなく炉内を流下してゆく。さらにこれら上部シールガスと下部シールガスの流量流速を各々に調整することで各々の流れを制御してシール効果を高め且つ炉内雰囲気の安定化をはかることができるので線引きされた光ファイバ7の線径変動が低減される。

ところで上記一実施例においては、シールガスの導入管が上部シールガス及び下部シールガスの各々のために1つずつ設けられていたが、円周方向により均一な流れを得るためにさらに導入管を増設してもよいし、シールガスの流路33，35の各々の絞り部31，32の取り付け位置をずらしたりその形状を変えて絞りの効果を調整することが可能である。また下部シールガスを予め加熱しておく予熱流路34についても伝熱面積をさらに大きくするために上記一実施例の円筒状の流路形状を例えば円周方向に波形状化したり、下部内周隔壁19の外周面に螺旋フィンを形成して予熱流路を螺旋状にしたり或は単に下部内周隔壁外周上下方向に板状フィンを多数設けてもよいし、予熱流路34を炉体12内のヒータ2近くまで接近させることで加熱効果をさらに向上させることなども考えられ、他に例えば構造部材についても、上部内隔壁23と下部内隔壁21とを一体の構造部材として構成することも可能であるし、要するにディフューザ8の内周壁面上部には不活性ガスの上部放出口30とその下方に位置する下部放出口29が設けられ同時にディフューザ8内には各々の放出口に独立して連絡する流路が設けられ且つ下部放出口29に至る流路にはディフューザ8の内周壁面に沿う予熱部を有するのであれば、その詳細な構造を特に問うものではない。

＜発明の効果＞

本発明の光ファイバ線引き炉によれば、線引きされる光ファイバ母材及び光ファイバを炉内にて外気よりシールするためのシールガスの放出口を2系統とし各々に独立した流路と導入管を設けることによって、各々の系統の放出口から放出されるシールガスが別々に線引き炉の上端開口部及び下端開口部とを外気からシールする。従ってこれら2系統のシールガスの流路流速を独立に制御することが可能でありこれを実行することによって線引き炉の上端開口部及び下端開口部でのシール効果をより完全なものに近ずけることができる。また同時に炉心管内を流下するシールガスにおいては、その流量流速を単独に微調整できることから、流れの安定化層流化をより実現しやすくなり、さらに、この線引き炉内を流下するシールガスは、予めディフューザ内周壁面に沿って形成された予熱部で加熱されているために炉内で加熱雰囲気と乱流を形成しにくく且つ光ファイバ母材を冷やすことがないので線引きされた光ファイバの線径変動を抑えることができる。またシールガスの加熱のために独立した加熱器を設けず、線引き炉本体の余熱を利用すると同時に、従来型のように上部シールガスまで加熱することがないので全般に熱効率を高めることが可能で運転コストを低減できる。

4. 図面の簡単な説明

第1図は本発明による光ファイバ線引き炉の

一実施例の概略構造を示す断面図、第２図は第１図に示した光ファイバ線引き炉のディフューザ部分の詳細な断面図、第３図は第２図に示した光ファイバ線引き炉のディフューザ部分のＡ－Ａ矢視断面図、第４図は従来の光ファイバ線引き炉の概略構造を示す断面図、第５図は第４図に示した光ファイバ線引き炉のディフューザ部分の詳細な断面図である。

図面中、１は光ファイバ母材、２はヒータ、３は炉心管、８はディフューザ、１２は炉体、１９は下部内周隔壁、２５は内フランジ、２９は下部放出口、３０は上部放出口、３３，３４は下部放出口に至る不活性ガス流路、３５，３６は上部放出口に至る不活性ガス流路である。

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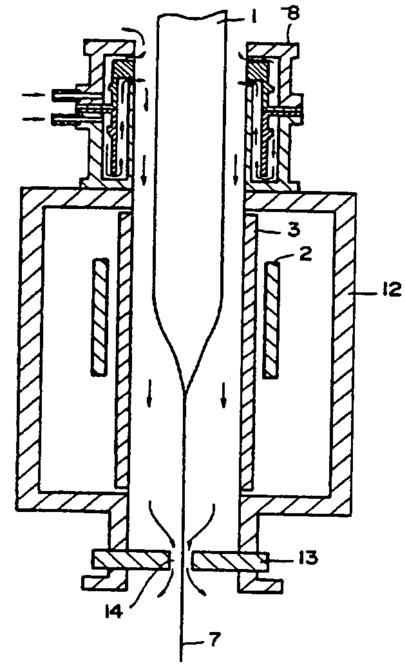
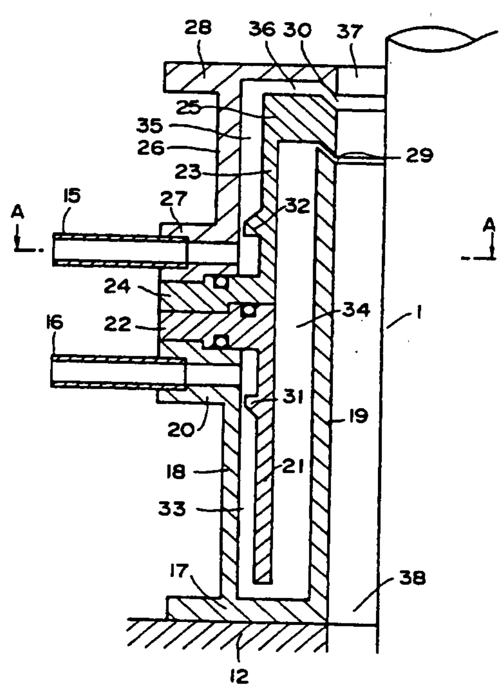
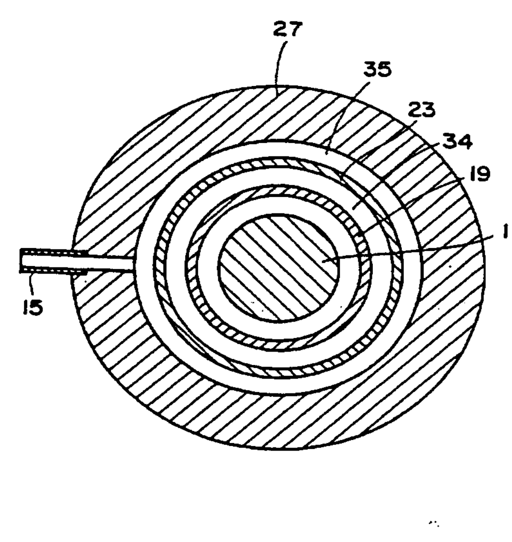
第１図



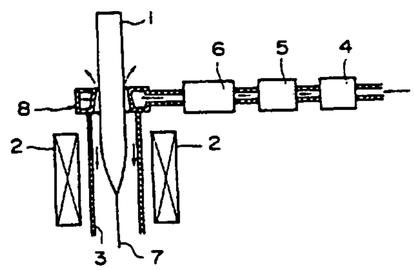
第２図



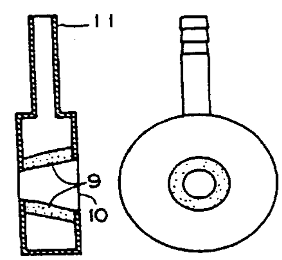
第３図



第 4 図



第 5 図



INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C03B37/029 C03B37/012 H05B6/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C03B H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	GB 1 523 595 A (NRD CORP.) 6 September 1978 (1978-09-06) page 3, line 28 - line 35; claims 1,5; figure 1	1,2 4,6
X A	US 4 030 901 A (P.KAISER) 21 June 1977 (1977-06-21) column 3, line 5 - line 14; claim 1; figure 2	1,2 4,6
A	US 5 284 499 A (J.A.HARVEY ET AL.) 8 February 1994 (1994-02-08) cited in the application column 4, line 60 -column 5, line 18; figure 2	1,6

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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Date of the actual completion of the international search	Date of mailing of the international search report
11 September 2000	19/09/2000

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/EP 00/04134

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2 368 677 A (ETAT FRANÇAIS (CNET)) 19 May 1978 (1978-05-19) cited in the application claims 1,3,4; figures 1,6,7 ---	1,6
A	FR 2 340 519 A (ETAT FRANÇAIS (CNET)) 2 September 1977 (1977-09-02) page 2, line 27 - line 31; claims 1,6,7; figure 1 page 3, line 9 - line 18 ---	1,6
A	PATENT ABSTRACTS OF JAPAN vol. 18, no. 625, 29 November 1994 (1994-11-29) & JP 06 239639 A (FURUKAWA ELECTRIC CO. LTD.), 30 August 1994 (1994-08-30) abstract ---	1,6
A	EP 0 795 519 A (ALCATEL FIBRES OPTIQUES) 17 September 1997 (1997-09-17) claims 1-3; figure 1 ---	1,6
A	GB 2 212 151 A (STC PLC) 19 July 1989 (1989-07-19) page 4, paragraph 5; figure 1 ---	1,6
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 205, 9 September 1983 (1983-09-09) -& JP 58 104032 A (NT&T CORP.), 21 June 1983 (1983-06-21) abstract; figures 1,2,4 ---	6,9,10
A	PATENT ABSTRACTS OF JAPAN vol. 12, no. 128, 20 April 1988 (1988-04-20) -& JP 62 246837 A (SUMITOMO ELECTRIC IND. LTD.), 28 October 1987 (1987-10-28) abstract; figures 1-3 ---	1,6
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 8, 30 August 1996 (1996-08-30) & JP 08 091862 A (SUMITOMO ELECTRIC IND. LTD.), 9 April 1996 (1996-04-09) abstract ---	4,5, 17-19
A	PATENT ABSTRACTS OF JAPAN vol. 16, no. 496, 14 October 1992 (1992-10-14) -& JP 04 182331 A (FURUKAWA ELECTRIC CO. LTD.), 29 June 1992 (1992-06-29) abstract column 7; figures 1,2 ---	4,5, 17-19

-/--

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/04134

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 893 416 A (ALCATEL ALSTHOM CGE) 27 January 1999 (1999-01-27) column 3, line 13 - line 18; figure 1	1,6
A	EP 0 803 478 A (ALCATEL FIBRES OPTIQUES) 29 October 1997 (1997-10-29) column 5, line 44 - line 53; figure 4	1,6
A	DE 40 06 839 A (AEG KABEL AG) 12 September 1991 (1991-09-12) figure 1	13,15
A	DE 39 03 466 A (AEG KABEL AG) 9 August 1990 (1990-08-09) figures 2,4-6	6,13,15
A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 11, 29 November 1996 (1996-11-29) & JP 08 188440 A (SUMITOMO ELECTRIC IND. LTD.), 23 July 1996 (1996-07-23) abstract	13,15
A	EP 0 867 412 A (ALCATEL ALSTHOM CGE) 30 September 1998 (1998-09-30) column 2, line 50 -column 3, line 57; figures 1,3,4	22-25
A	U.C.PAEK ET AL.: "Fiber drawing from 7.5 cm diameter preforms at high speed" OPTICAL FIBER COMMUNICATION CONFERENCE. (OFC),US,NEW YORK, IEEE, vol. CONF. 11, 1988, pages 222-225, XP000011691 ISBN: 1-55752-022-4 page 223; figure 1B	6,26
A	EP 0 743 289 A (AT&T IPM CORP.) 20 November 1996 (1996-11-20) column 3, line 5 - line 11	6,26
A	M.RAJALA ET AL.: "COMBINATION FURNACE FOR DRAWING LARGE OPTICAL FIBRE PREFORMS AT HIGH SPEED" PROCEEDINGS OF 47TH INTERNATIONAL WIRE AND CABLE SYMPOSIUM, 16 - 19 November 1998, pages 483-488, XP000856139 cited in the application page 483 page 486	6,26

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 00/04134

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
GB 1523595	A	06-09-1978	NONE			
US 4030901	A	21-06-1977	NONE			
US 5284499	A	08-02-1994	AU	3715793	A	04-11-1993
			CA	2084258	A	02-11-1993
			DE	69311841	D	07-08-1997
			DE	69311841	T	12-02-1998
			EP	0567961	A	03-11-1993
			HK	1000532	A	03-04-1998
			JP	6080437	A	22-03-1994
FR 2368677	A	19-05-1978	NONE			
FR 2340519	A	02-09-1977	NONE			
JP 06239639	A	30-08-1994	NONE			
EP 0795519	A	17-09-1997	FR	2746176	A	19-09-1997
			US	5970083	A	19-10-1999
GB 2212151	A	19-07-1989	US	4988374	A	29-01-1991
JP 58104032	A	21-06-1983	NONE			
JP 62246837	A	28-10-1987	NONE			
JP 08091862	A	09-04-1996	NONE			
JP 04182331	A	29-06-1992	JP	2807335	B	08-10-1998
EP 0893416	A	27-01-1999	FR	2766480	A	29-01-1999
EP 0803478	A	29-10-1997	FR	2747673	A	24-10-1997
			DE	69700513	D	21-10-1999
			DE	69700513	T	04-05-2000
			JP	10067532	A	10-03-1998
			US	5931984	A	03-08-1999
DE 4006839	A	12-09-1991	NONE			
DE 3903466	A	09-08-1990	NONE			
JP 08188440	A	23-07-1996	NONE			
EP 0867412	A	30-09-1998	EP	0867413	A	30-09-1998
			EP	0867414	A	30-09-1998
			JP	11079776	A	23-03-1999
			JP	11079778	A	23-03-1999
			JP	11071127	A	16-03-1999
EP 0743289	A	20-11-1996	DE	69601660	D	15-04-1999
			DE	69601660	T	02-09-1999
			JP	8319130	A	03-12-1996
			US	5698124	A	16-12-1997